LHC impedance and multibunch modes

First comparison between phase 1 and IR3MBC (combined momentum and betatron cleaning in IR3 – settings from A. Rossi)

!! Preliminary results !! (some effects, such as temperature, not taken into account)
Multibunch modes: horizontal

Better in horizontal, but...
Multibunch modes: vertical

In particular, huge tune shift ($\sim 1.3 \times 10^{-3}$) with IR3MBC option.

… worse in vertical.

Sacherer vertical tune shifts for all the coupled–bunch modes and $m=0$ (current LHC impedance model at 7000GeV, intensity $1.15 \times 10^{11} H^+$)
Horizontal and vertical dipolar (driving) impedance

⇒ Confirm a much stronger vertical impedance with IR3MBC w.r.t. phase 1 (red vs. magenta) above $\sim 10^5$ Hz

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Largest impedance contributors in IR3MBC configuration

For those horizontal collimators:
- very small halfgap due to small $\sigma$ (from small $\beta_x$),
- quite large $\beta_y$,  
$\Rightarrow$ Large vertical impedance  
(not but horizontal since $\beta_x$ is 10 times smaller).

Settings from A. Rossi

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Vertical dipolar impedance: largest contributors

Rest of the machine = everything that is not a collimator in the current impedance model

⇒ Above a few MHz, one single IR3MBC collimator gives the same imag. part as the totality of the phase 1 collimators.
Conclusions

- At 7TeV, with the IR3MBC option, the horizontal impedance is lower than in phase 1, but the vertical one is much larger (for the imaginary part, factor between 1.5 at 10kHz and 3 at 10 GHz).

- In consequence, the multibunch transverse instability (thought to be the most critical effect at 7TeV) is a more critical issue than in phase 1 (well beyond the stability diagram).

- Also, the tune shift is very large ⇒ could trigger other problems?

- The effect on single-bunch stability of such an impedance could be even worse since the factor between IR3MBC and phase 1 increases at high frequency ⇒ Headtail simulations to check this are planned.
Reminder: stability diagram (from Elias Métral’s previous presentation at CWG on June 7th, 2010)

Sacherer horizontal tune shifts for all the coupled-bunch modes and m=0
(current LHC impedance model at 7000 GeV, intensity 1.15 $10^{11}$ Hz)

Sacherer vertical tune shifts for all the coupled-bunch modes and m=0
(current LHC impedance model at 7000 GeV, intensity 1.15 $10^{11}$ Hz)